



Cross Compiling vxWorks on Linux

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David Thompson

thompsonDH@ornl.gov

Ernest Williams

ernesto@sns.gov



Outline



- **Why do we want to migrate to Linux**
- **Problems with the public releases of GCC**
- **How to get the sources from WRS**
- **How to build the compiler and problems**
- **Missing parts**
- **Results and experiences**

Motivation to use Linux



- **Linux is the OS selected for servers and displays in the SNS control system**
- **Linux is the development platform for Epics at the SNS**
 - » **Epics tools**
 - » **C/C++ development tools for VxWorks**
- **Linux is stable, state of the art, and free**
- **Runs on low cost, reliable, and fast hardware**

Why public versions of GCC won't do



- For “C” only, EPICS R3.13 versions, public GCC versions through 2.95 work fine
- EPICS R3.14 code crashed
 - » 3.14 contains more C++ code
 - » Problem traced to exceptions
 - » WRS cross compiler (-S) produced different code compared to gcc-2.95 cross compiler on Linux
 - » No public compiler that we found matched the output from WRS’s compiler
 - » Kernel is the location of WRS proprietary exception handling code that works with their compiler

The Compiler that WRS ships is not public

- **CC/g++ driver version “cygnus-2.7.2-960126 and egcs-971225 is the version reported by the Solaris T202 compiler**
- **The WRS 2.7.2 not in GNU CVS repository**
 - » **GCC 2.7.2 Released November 26, 1995**
 - » **EGCS dates 960126 and 971225 do not match dates in GCC release history**
 - » **“Real” GCC 2.7.2 does not report an EGCS version**
 - » **Dates closer to EGCS 1.0 and 2.90.21, but not same**
- **WRS’s version not found in GNU’s archive**

How not to crack the exception problem



- **Replace the exception code in the kernel**
 - » **Use the public code in libgcc**
 - Libgcc appears to have vxWorks support
 - This code is not complete
 - Does not appear to be re-entrant in critical ways
 - » **Reverse engineer the exception code in the kernel**
 - Too much time without sources
 - No way or time to test to required reliability levels
 - » **We do not have kernel sources \$\$\$\$**
- **Fix a public compiler to generate the same code**

How WRS complies with the GPL



- They make the source code to the compiler and binutils available to their licensees at no cost
- Ordering info for the GNU source
 - » CD Title: Tornado 2.0 GNU Source
 - » WRS Part No: TDK-12878-ZC GNU Source

Thanks to Andrew Johnson and Jeff Hill for suggesting that WRS should provide the source code and Ernest for getting it.

WWW <http://www.wrs.com>
S.A.R.L. 33-1-60-92-63-00
GmbH 49-89-96-24-45-0
UK Ltd. 44-121-359-0999
Japan 81-03-5467-5900

Build Problems and solutions



- **There is a lot of source code on the CD**
 - » Had to sort out just the needed parts
 - » Prior experience building and using old GCC versions with vxWorks
- **There are several versions of the GNU sources on the CD**
 - » I found the right one by searching for the version strings
- **Developed build and compile script to document and automate config and build steps**
- **Built on RH 7.0, 7.1, and 7.2**
- **All components have to be configured with same --prefix, --target, etc.**

Build Problems and solutions –2



- **Errors that I encountered in the build**
 - » **Some error came from building libs and tools that are not needed, these were eliminated from the build**
 - » **Errors in the compiler in an obscure function:**

```
make[1]: Entering directory `~/sns/ADE/home/thompson/obj-ppc/cpp/gcc'
cc -c -DCPU=PPC603 -DCROSS_COMPILE -DIN_GCC -g -I. -I/sns/ADE/home/thompson/t202-cross-gcc/t202/host/src/gnu.cpp/gcc -I/sns/ADE/home/thompson/t202-cross-gcc/t202/host/src/gnu.cpp/gcc/config /sns/ADE/home/thompson/t202-cross-gcc/t202/host/src/gnu.cpp/gcc/bc-emit.c
In file included from /sns/ADE/home/thompson/t202-cross-gcc/t202/host/src/gnu.cpp/gcc/bc-emit.c:948:
/sns/ADE/home/thompson/t202-cross-gcc/t202/host/src/gnu.cpp/gcc/bc-typecd.def: In function
`bc_emit_instruction':
/sns/ADE/home/thompson/t202-cross-gcc/t202/host/src/gnu.cpp/gcc/bc-typecd.def:17: `SFtype' is
promoted to `double' when passed through `...'
/sns/ADE/home/thompson/t202-cross-gcc/t202/host/src/gnu.cpp/gcc/bc-typecd.def:17: (so you should
pass `double' not `SFtype' to `va_arg')
make[1]: *** [bc-emit.o] Error 1
```

Ways to fix bc_emit_instruction() function



- **GCC 2.7.2 is a little old, maybe an old compiler will compile it without errors**
 - » **KGCC was used to build Linux kernels versions 2.2 and below and is egcs-2.91**
 - » **KGCC builds the cross compiler without errors**
- **Do what the compiler suggests and change Sftype to double**
 - » **What will that do and when will it come back to bite me?**
 - » **For a test I placed an assert(0) in bc_emit_instruction() but could not cause compiler to call it**
 - » **Does bc_emit_function have to do with VARGS or maybe float literals?**
 - » **The compiler seems to work ok, maybe it's worth the risk?**

Ways to fix bc_emit_instruction() function -2

- The bc_emit_instruction() function is only called when the -fbytecode flag is set and that is only supported for 68K
- The function is unreachable in the PPC cross compiler and does not affect the 68K compiler unless you need bytecodes
- I suggest the following change to bc-emit.c:

At the top:

```
#include <assert.h>
```

After the existing variable declarations in bc_emit_instruction() add:

```
typedef double SFtype; // To get rid of the error
```

```
assert(0); // To make sure it won't work
```

- Now the fix is safe....

How to get started



- **Get the CD**
 - » You need a license key and an existing working installation of VxWorks, move the files to Linux when the installer finishes
 - » After installation there will be a gnu and a gnu.cpp directory under \$WIND_BASE/host/src
- **Download the build script and patch file from SNS**
ftp://snsftp.sns.ornl.gov/UPLOAD/controls/EPICS-Spring02/mkPPCgcc
Place the script in \$WIND_BASE/host/src
Get and apply patch-gnu.txt from the same site
Configure the file for your installation
make -f mkPPCgcc
make -f mkPPCgcc build
68K: Please contact me for the file

Cross compiler build notes



- **Uncomment the following line in the script if you have kgcc and want to use it:**

`#KGCC_LINKS=kgcc_links`

-OR-

- **Fix `bc_emit_instruction()` in `./gnu.cpp/gcc/bc-emit.c`**

Other notes:

- **The make script fixes some errors that cause compile errors and skips code not needed**
- **Don't do a make clean anywhere in the source tree!**

Experience building Epics



- You will need to modify **CONFIG.Vx** and the **CONFIG_SITE** files for the targets that you use
Get the `README.sns.txt` from the SNS ftp server
- If you have used another gcc for cross compiling on Linux you will need to rebuild the Epics library files for vxWorks, especially R3.14
- All SNS controls Epics development has migrated to Linux

Experience Building VxWorks Kernels



- **Make a copy of the vxworks sources, header files and library files accessible on linux.**
- **vxWorks Kernel**
 - Need only a public elfXsyms tool
elfSym.c supplied by Richard Dabney at LANL.
elfXsyms strips out everything but the symbol table from an elf
file: vxWorks.sym= symbol table from vxWorks file
- **Bootrom Kernel**
 - Need romsize, and elfToBin.
 - » /bin/true can stand in for romsize
 - » elfToBin: Objdump utility almost does the job, starts from 0x0
and not the base of the rom
 - » This utility needs to be written

Modifications to the kernel Makefile



- Fake the romsize tool

```
ifeq "$(OSTYPE)" "linux-gnu"
```

```
ROMSIZEPROG=/bin/true
```

```
endif
```

- Make sure that the elfXsyms replacement can be found

WRS ??



- **Is a Linux development platform for Tornado in the works?**
- **Will WRS dump Unix altogether and only support the Tornado GUI on WinTel?**
- **What version of GCC will be in the next release or will it be something else?**
 - » What about Diab c/c++ ?
- **WRS has bought FreeBSD, what does that mean?**

Conclusions



- **SNS has been using the cross compiler for the PPC based MVME2100 for several months.**
- **Migration to Epics 3.14 in progress**
- **No problems experienced, produces identical binaries as Solaris based cross compiler supplied by WRS**
- **Straight forward setup to build the cross compiler with SNS script**

Location of scripts and patch files

<ftp://snsftp.sns.ornl.gov/UPLoad/controls/EPICS-Spring02/>